

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Cancelled)
2. (Cancelled)
3. (Cancelled)
4. (Cancelled)
5. (Cancelled)
6. (Cancelled)

7. (Currently Amended) A wireless communication receiver comprising:
an antenna array comprising an antenna which provides signals for each of
successive sets of pilot data;
a joint searcher and channel estimator arranged to essentially concurrently
consider plural signals for the respective successive sets of pilot data for determining
both a time of arrival and channel coefficient. ~~The apparatus of claim 6;~~
wherein each of the sets of pilot data is represented by a pilot set index, and
wherein the joint searcher and channel estimator comprises:
an antenna signal matrix in which a complex value indicative of the signal
received in a sampling window is stored as a function of a sampling window time index
and the pilot set index;
a correlator configured to use the antenna signal matrix to generate a
correlator output;
a correlator output analyzer configured to use the correlator output to
generate the time of arrival and the channel coefficient;

wherein in performing the calculation the correlator considers a dimensional
receptivity vector formed from the antenna signal matrix with respect to a sampling
window time index for the ~~plural~~ successive sets of pilot data, the dimensional receptivity
vector having a frequency related to a difference between phase components of complex
values of the dimensional receptivity vector, there being plural possible frequencies for
the dimensional receptivity vector, the plural possible frequencies being represented by a
frequency index; and

wherein for each combination of plural possible frequencies and plural time
indexes, the correlator configured to calculate:

$$Y(n,t) = \text{FFT}(n, X(:,t))$$

wherein t is the sampling window time index;

X(:,t) is the complex antenna matrix; and

n is the frequency index.

8. (Previously Presented) The apparatus of claim 7, wherein for each combination of plural possible frequencies and plural time indexes, the correlator being configured to calculate:

$$Y(n,t) = \sum C_j * \text{FFT}(n, X(:,t)), j = 1, K$$

wherein C_j is a coding sequence symbol value j and K is a length of the coding sequence.

9. (Original) The apparatus of 7, wherein each of the plural possible frequencies corresponds to a doppler shift.

10. (Previously Presented) The apparatus of 9, wherein the correlator output comprises $Y(n,t)$, and wherein the analyzer is configured to determine a maximum absolute value $|Y(n,t)|_{\max}$, wherein the analyzer uses a sampling window time index t_{\max} at which $|Y(n,t)|_{\max}$ occurs to determine the time of arrival of an arriving wavefront; and wherein the analyzer uses the a frequency index n_{\max} at which $|Y(n,t)|_{\max}$ to determine the doppler shift.

11. (Original) The apparatus of 7, wherein the correlator output comprises $Y(n,t)$, and wherein the analyzer determines a maximum absolute value $|Y(n,t)|_{\max}$, wherein the analyzer obtains an amplitude for an arriving wavefront by dividing $|Y(n,t)|_{\max}$ by a number of sets of pilot data in the series.

12. (Cancelled)

13. (Cancelled)

14. (Cancelled)

15. (Cancelled)

16. (Cancelled)

17. (Cancelled)

18. (Cancelled)

19. (Cancelled)

20. (Cancelled)

21. (Cancelled)

22. (Currently Amended) A method of operating a wireless communication receiver comprising:
obtaining from an antenna element signals for each of successive sets of pilot data;
concurrently using the signals for each of successive sets of pilot data for
determining both a time of arrival and channel coefficient;~~The method of claim 21,~~
wherein each of the sets of pilot data is represented by a pilot set index, wherein
the step of concurrently using the plural signals for determining both the time of arrival
and the channel coefficient is performed by a joint searcher and channel estimator, and
further comprising the steps of the joint searcher and channel estimator:
storing a complex value indicative of the signal received in a sampling window an
antenna signal matrix as a function of a sampling window time index and the pilot set
index;
performing a Fast Fourier Transformation (FFT) calculation to generate a
correlator output;
using the correlator output to generate the time of arrival and the channel
coefficient;

wherein in performing the calculation the correlator considers
a dimensional receptivity vector formed from the antenna signal matrix with
respect to a sampling window time index for the plural sets of pilot data, the dimensional
receptivity vector having a frequency related to a difference between phase components
of complex values of the dimensional receptivity vector, there being plural possible
frequencies for the dimensional receptivity vector, the plural possible frequencies being
represented by a frequency index; and

wherein for each combination of plural possible doppler frequencies and plural
time indexes, the correlator calculates:

$$Y(n,t) = \text{FFT}(n,X(:,t))$$

wherein t is the sampling window time index;

$X(:,t)$ is the complex antenna matrix; and

n is the doppler frequency index.

23. (Original) The method of claim 22, wherein for each combination of plural possible frequencies and plural time indexes, the method comprises evaluating the following expression:

$$Y(n,t) = \sum C_j * \text{FFT}(n, X(:,t)), j = 1, K$$

wherein C_j is a coding sequence symbol value j and K is the length of the coding sequence.

24. (Original) The method of claim 22, wherein the correlator output comprises $Y(n,t)$, and further comprising determining a maximum absolute value $|Y(n,t)|_{\max}$.

25. (Original) The method of 24, further comprising:
using a sampling window time index t_{\max} at which $|Y(n,t)|_{\max}$ occurs to determine the time of arrival of an arriving wavefront; and
using the doppler frequency index n_{\max} at which $|Y(n,t)|_{\max}$ to determine the doppler shift direction.

26. (Original) The method of 24, further comprising obtaining an amplitude for the arriving wavefront by dividing $|Y(n,t)|_{\max}$ by a number of sets of pilot data in the series.

27. (Cancelled)

28. (Cancelled)

29. (Cancelled)

30. (Cancelled)

31. (Currently Amended) The apparatus of claim 31, wherein the joint searcher and channel estimator is arranged to essentially concurrently consider the plural signals for the respective successive sets of pilot data for determining both a time of arrival and channel coefficient by essentially concurrently operating upon a two dimensional functionally dependent matrix, the signals being stored in the matrix as a function of two different indices, a first index being a time index of a sampling window employed for each of the sets of pilot data and a second index indicating for which one of the successive sets of pilot data the signal was obtained.

32. (Currently Amended) The apparatus of claim ~~17~~, wherein the joint searcher and channel estimator is arranged to essentially concurrently consider the plural signals for the respective successive sets of pilot data for determining both a time of arrival and channel coefficient by essentially concurrently operating upon a matrix which stores signals which are dimensionally differentiated by being acquired in differing frame transmission intervals.

33. (Currently Amended) The method of claim ~~16~~21, further comprising concurrently using the signals for each of successive sets of pilot data for determining both a time of arrival and channel coefficient by essentially concurrently operating upon a two dimensional functionally dependent matrix, the signals being stored in the matrix as a function of two different indices, a first index being a time index of a sampling window employed for each of the sets of pilot data and a second index indicating for which one of the successive sets of pilot data the signal was obtained.

34. (Currently Amended) The method of claim ~~16~~21, further comprising concurrently using the signals for each of successive sets of pilot data for determining both a time of arrival and channel coefficient by essentially concurrently operating upon a matrix which stores signals which are dimensionally differentiated by being acquired in differing frame transmission intervals.

35. (Cancelled)

36. (Currently Amended) The apparatus of claim ~~35~~40, wherein the joint searcher and channel estimator is arranged to essentially concurrently consider the dimensionally differentiated plural signals provided by the plural antennas for determining plural times of arrival and plural channel coefficients, an arriving wavefront being represented by one of the plural times of arrival and a corresponding one of the plural channel coefficients.

37. (Currently Amended) The apparatus of claim ~~35~~40, wherein the antenna structure comprises an array of plural antennas, and wherein the signals acquired by different antennas of the array are dimensionally differentiated with regard to a spatial dimension.

38. (Currently Amended) The apparatus of claim ~~35~~40, wherein the antenna structure comprises an antenna arranged to provide signals for each of successive sets of pilot data received by the antenna as the dimensionally differentiated signals, whereby the signals acquired by the antenna are dimensionally differentiated with regard to a temporal dimension.

39. (Cancelled)

40. (Currently Amended) A wireless communication receiver comprising:
an antenna structure arranged to acquire dimensionally differentiated signals;
a joint searcher and channel estimator arranged to essentially concurrently
consider the dimensionally differentiated plural signals provided by the antenna structure
for determining both a time of arrival and channel coefficient; The apparatus of claim 39,
wherein the joint searcher and channel estimator comprises:
an antenna signal matrix in which complex values indicative of the
dimensionally differentiated signal received in a sampling window are stored as a
function of a sampling window time index and a dimensional differentiation index;
a correlator arranged to locate value(s) in the antenna signal matrix for use
in determining the time of arrival and the channel coefficient;
an analyzer arranged to use the value(s) located by the correlator to
generate the time of arrival and the channel coefficient;

wherein in locating the values the correlator considers a dimensional reception vector formed from the antenna signal matrix with respect to a sampling window time index, the dimensional receptivity vector having a frequency related to a difference between phase components of complex values of the dimensional receptivity vector, there being plural possible frequencies for the dimensional receptivity, the plural possible frequencies being represented by a frequency index; and

wherein for each combination of plural possible frequencies and plural time indexes, the correlator is arranged to calculate:

$$Y(n,t) = \text{FFT}(n,X(:,t))$$

wherein t is the sampling window time index;

X(:,t) is the complex antenna matrix, with : representing all antenna indexes for one sampling window time index;

n is the frequency index.

41. (Previously Presented) The apparatus of claim 40, wherein for each combination of plural possible frequencies and plural time indexes, the correlator is further arranged to calculate:

$$Y(n,t) = \sum C_j * \text{FFT}(n, X(:,t)), j = 1, K$$

wherein C_j is a coding sequence symbol value j and K is a length of the coding sequence.

42. (Previously Presented) The apparatus of claim 40, wherein the antenna structure comprises an array of plural antennas, and wherein each of the plural possible frequencies for the dimensional receptivity vector represents a different possible direction of arrival of the arriving wavefront.

43. (Previously Presented) The apparatus of claim 40, wherein the antenna structure comprises an antenna which provides signals for each of successive sets of pilot data received by the antenna as the dimensionally differentiated signals, and wherein each of the plural possible frequencies corresponds to a doppler shift.

44. (Cancelled)

45. (Cancelled)

46. (Cancelled)

| 47. (Currently Amended) The method of claim ~~46~~50, wherein the antenna structure comprises an array of plural antennas, and further comprising acquiring the dimensionally differentiated signals from different antennas of the array whereby the signals are dimensionally differentiated with regard to a spatial dimension.

| 48. (Currently Amended) The method of claim ~~46~~50, further comprising receiving, at an antenna of the antenna structure, signals for each of successive sets of pilot data received by the antenna as the dimensionally differentiated signals, whereby the signals acquired by the antenna are dimensionally differentiated with regard to a temporal dimension.

49. (Cancelled)

50. (Currently Amended) A method of operating a wireless communication receiver comprising:
acquiring dimensionally differentiated signals at an antenna structure;
concurrently using the dimensionally differentiated signals for determining both a time of arrival and channel coefficient;~~The method of claim 49,~~
storing, in an antenna signal matrix, complex values indicative of the dimensionally differentiated signals received in a sampling window as a function of a sampling window time index and a dimensional differentiation index;
locating value(s) in the antenna signal matrix for use in determining the time of arrival and the channel coefficient;
using the value(s) located to generate the time of arrival and the channel coefficient;
wherein the step of locating the values further comprises using a dimensional reception vector formed from the antenna signal matrix with respect to a sampling window time index, the dimensional receptivity vector having a frequency related to a difference between phase components of complex values of the dimensional receptivity vector, there being plural possible frequencies for the dimensional receptivity, the plural possible frequencies being represented by a frequency index; and
wherein for each combination of plural possible frequencies and plural time indexes, calculating:
$$Y(n,t) = \text{FFT}(n,X(:,t))$$

wherein t is the sampling window time index;
X(:,t) is the complex antenna matrix, with : representing all antenna indexes for one sampling window time index;
n is the frequency index.

51. (Previously Presented) The method of claim 50, wherein for each combination of plural possible frequencies and plural time indexes, calculating:

$$Y(n,t) = \sum C_j * \text{FFT}(n, X(:,t)), j = 1, K$$

wherein C_j is a coding sequence symbol value j and K is a length of the coding sequence.

52. (Previously Presented) The method of claim 50, wherein the antenna structure comprises an array of plural antennas, and wherein each of the plural possible frequencies for the dimensional receptivity vector represents a different possible direction of arrival of the arriving wavefront.